



Assessment Tools and Techniques to Measure and Diagnose Issues with Vertical Equity

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INTERNATIONAL RESEARCH SYMPOSIUM

Amsterdam, The Netherlands · December 4 - 5, 2024

Renewed Focus on Property Tax Equity in the Academia.....

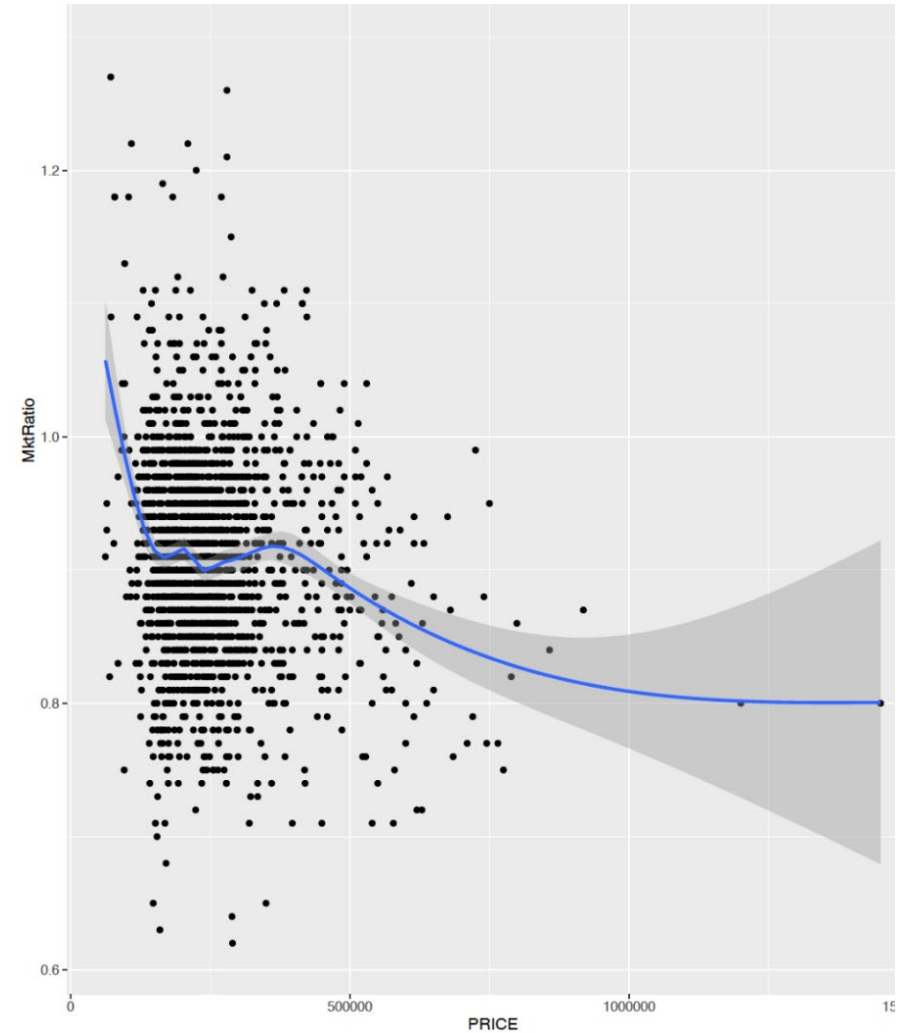
- ✓ *Reassessing the Property Tax*, Christopher Berry, The University of Chicago Harris School of Public Policy and the College. 2021
- ✓ *The Assessment Gap: Racial Inequalities in Property Taxation*. Carlos Avenancio-León, Indiana University and Troup Howard, University of California, Berkeley. 2020
- ✓ *Why are Residential Property Tax Rates Regressive?* Natee Amornsiripanitch, Federal Reserve Bank of Philadelphia. 2020

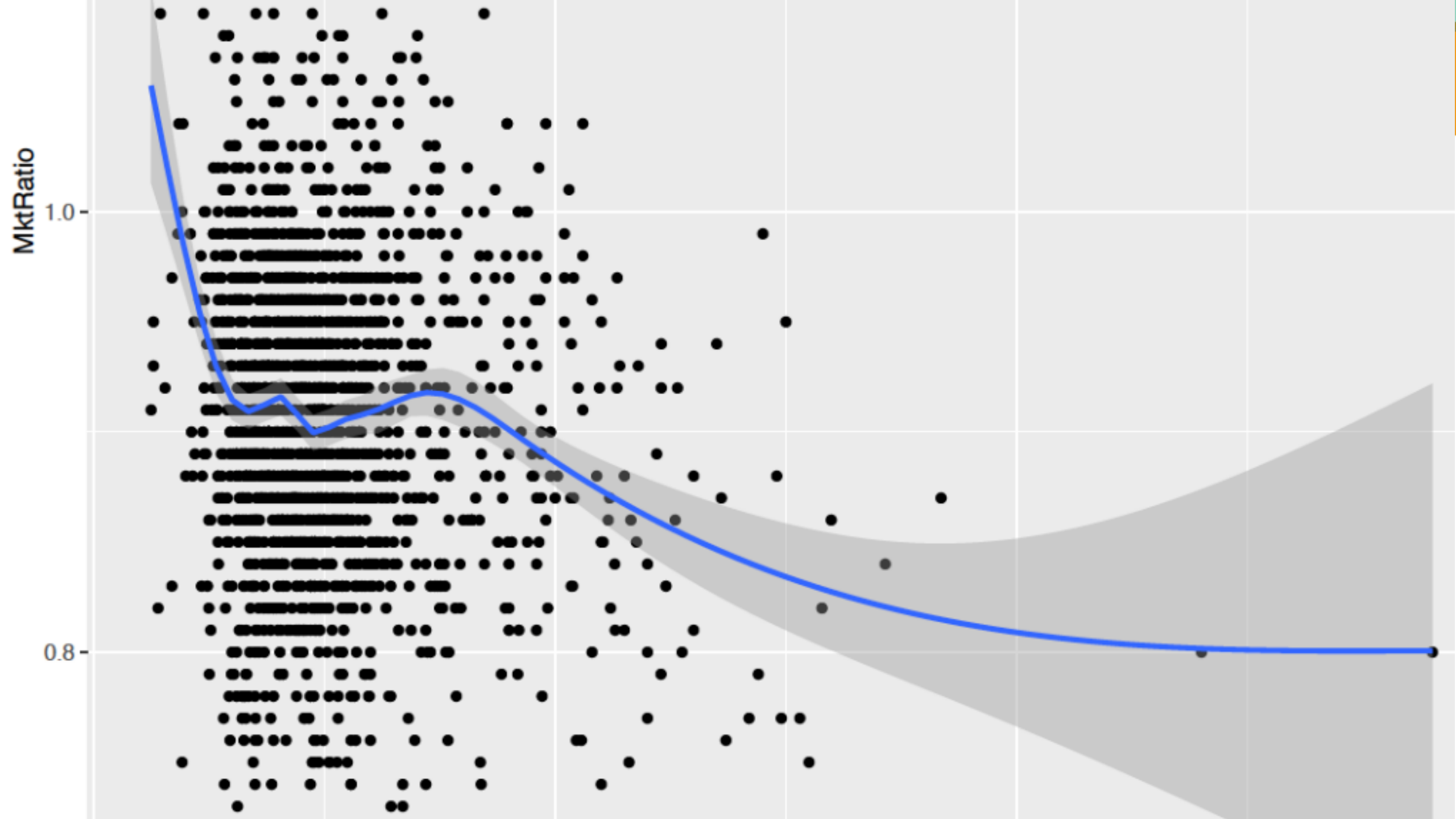


*All find significant levels of **regressivity** in assessments using national datasets*

What is Vertical Equity

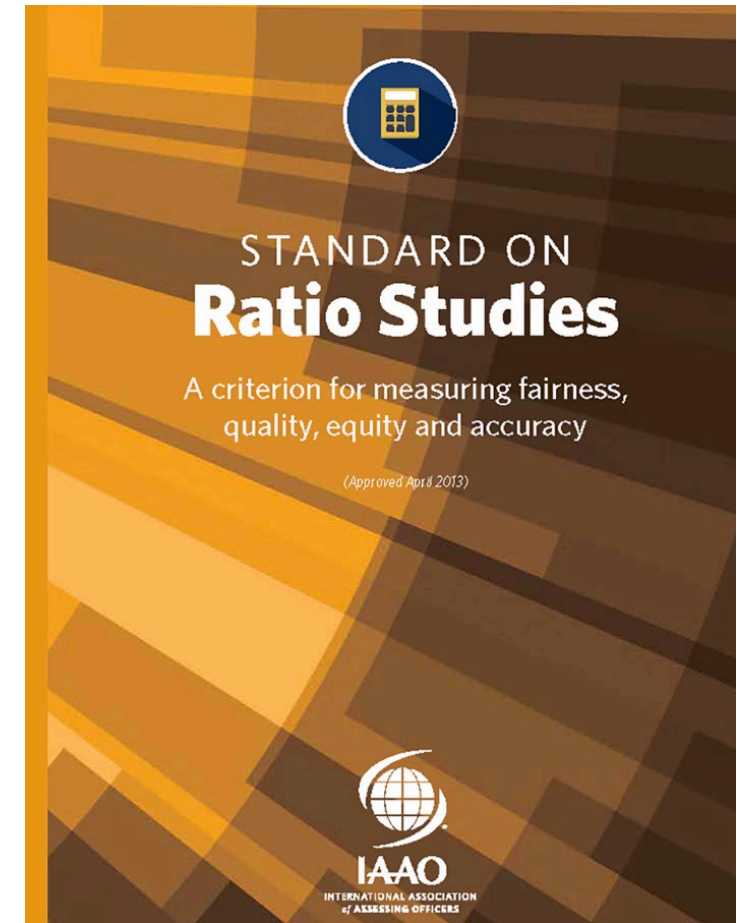
- Vertical equity exists when sales ratios (assessment / sale price) are consistent between lower, middle, and upper-priced properties.
- Sale ratios should be uniform, regardless of price.
- If ratios do fluctuate across prices, vertical inequity is suggested to exist.
- Primary types of vertical inequity:
 - **Regressivity: ratios are lower among higher-priced properties**
 - **Progressivity: ratios are lower among lower-priced properties**





Measuring Vertical Equity

- Measuring vertical equity in assessments is challenging since the market value of any given property is unknown.
- Detailed guidance is provided by IAAO Standard on Sales Ratio Studies
- IAAO Vertical Equity Measures
 - **Price Related Differential (PRD)**
 - **Coefficient of Price Related Bias (PRB)**



Vertical Equity Measures in Standard

Price Related Differential - PRD

- The PRD as a vertical equity measure is useful but somewhat flawed.
 - Simple and easy to calculate, but
 - Results can be distorted by a few high-priced properties that can lead to a false indication of regressivity.
- The PRD can be a useful indicator that more analysis is necessary, but by itself it is not necessarily conclusive that vertical inequity exists.

Coefficient of Price Related Bias - PRB

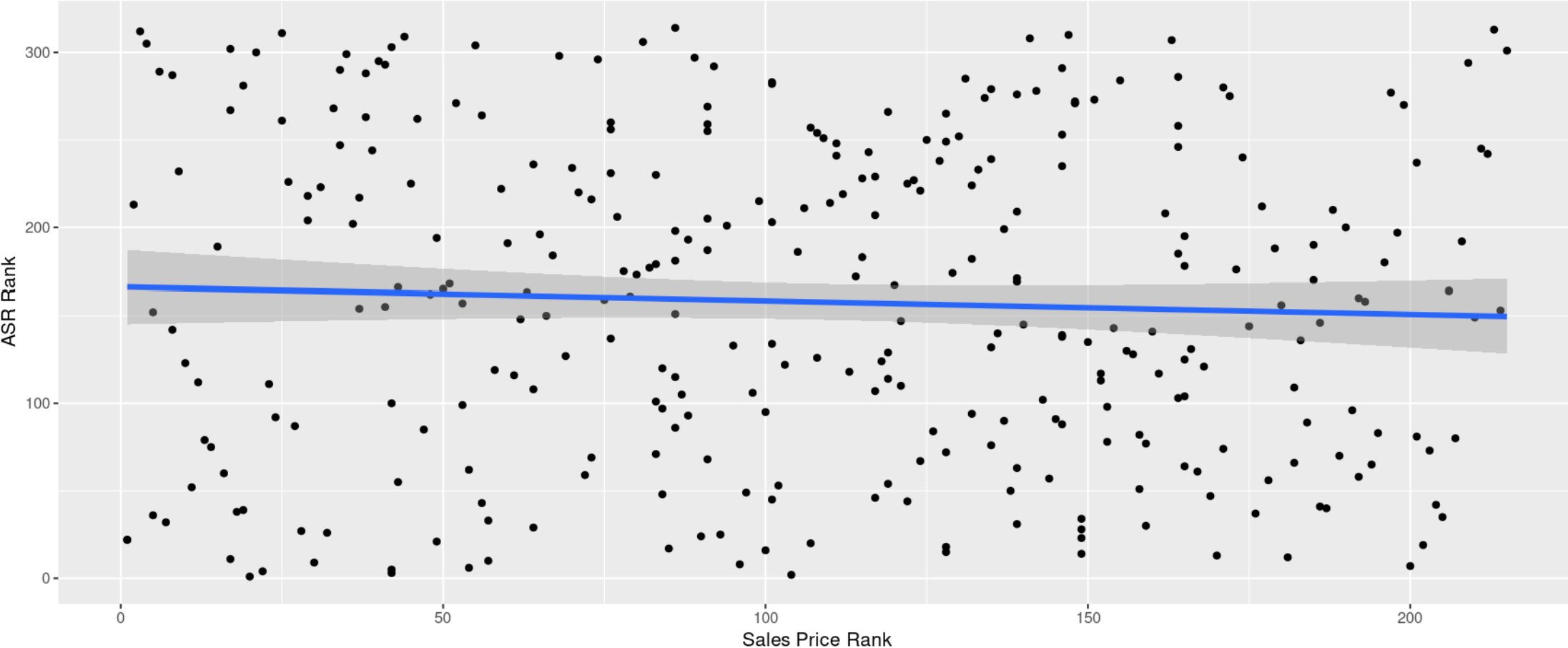
- More robust measure that is not as susceptible to the influence of outliers as the PRD, but.....
- The PRB is more difficult to calculate than the PRD.
- Some academic research has found that regression based vertical equity measures like the PRB may be prone to indicating a regressive distribution even if there is no bias present ([Measures of vertical inequality in assessments](#), McMillen & Singh, 2022).

Spearman's Rank-Order Correlation

- Spearman's Rank is also recommended in the IAAO Standard for evaluating whether low and high priced properties are appraised at equal percentages of market value i.e., whether vertical equity exists.
- The Spearman's Rank measures the strength and direction of association between two ranked variables – sales price and sales ratio.
- While the Spearman analysis provides useful information, since its a simple correlation it lacks other important information on the distribution.

Spearman's Rank-Order Correlation

Spearman's Rank-Order Correlation Plot



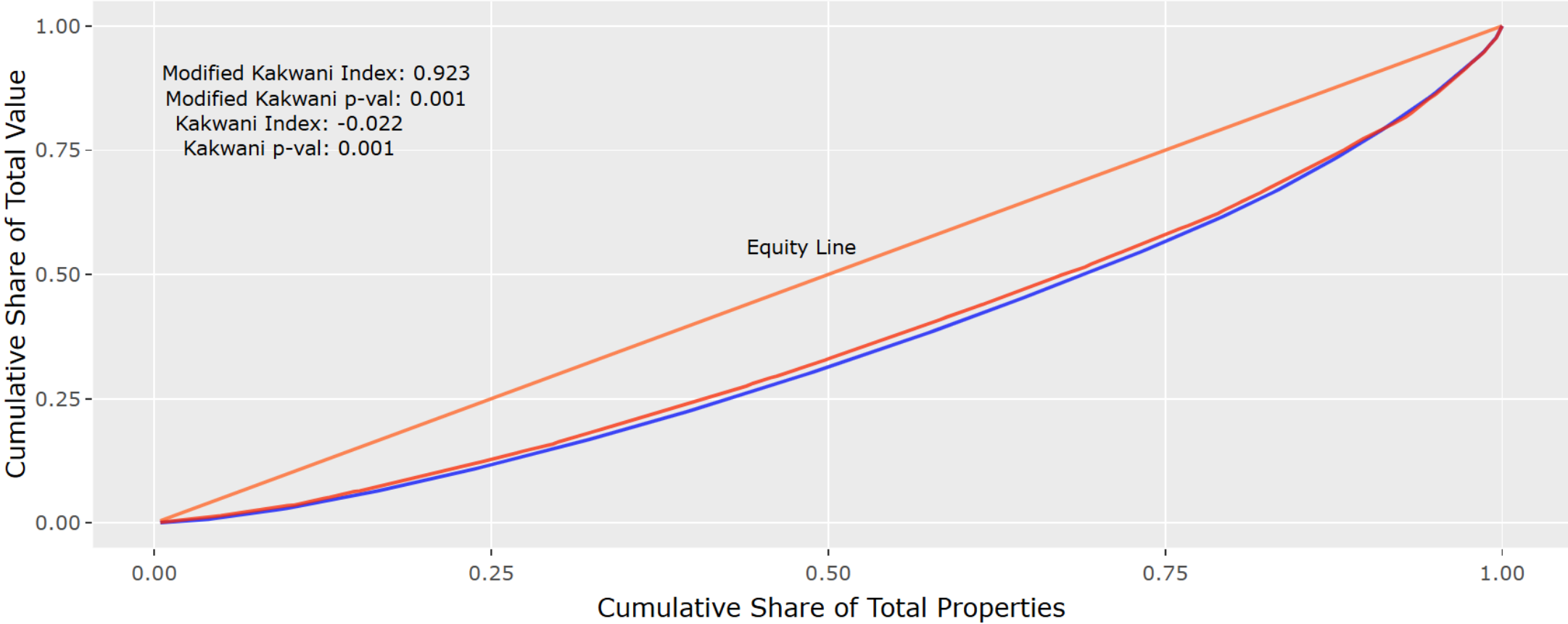
Gini Measures

- Gini measures - common measure of inequity in economic analysis for decades - only recently considered to measure vertical equity
- Ginis also use rankings of sales and assessments in their calculation.
- Ginis can also quantify how the distribution of assessments behave relative to the distribution of sales at given price levels.
- The Kakwani Index (KI) provides a measure that summarize the relationship of the sales and assessment distributions.
 - KI less than zero indicates regressivity
 - KI above zero indicates progressivity

[A Gini Measure for Vertical Equity in Property Assessments \(Quintos, 2021\)](#)

Gini Measures

Gini Measures Plot



Lincoln Institute's Vertical Equity App

- The notion of a single or best measure of vertical equity may be illusive.
 - Instead, the best approach may be to calculate and evaluate several measures to develop a more complete picture of the vertical equity for a given distribution.
“We do not recommend one particular test over another but rather that a suite of tests be reported to support the existence or absence of vertical equity.”
- IAAO Statistical Measures Task Force
- The Lincoln Institute developed the [Vertical Equity App](#) with the Center for Appraisal Research and Technology to provide a tool measure and evaluate vertical equity.

-PRD

-PRB

-Decile Analysis

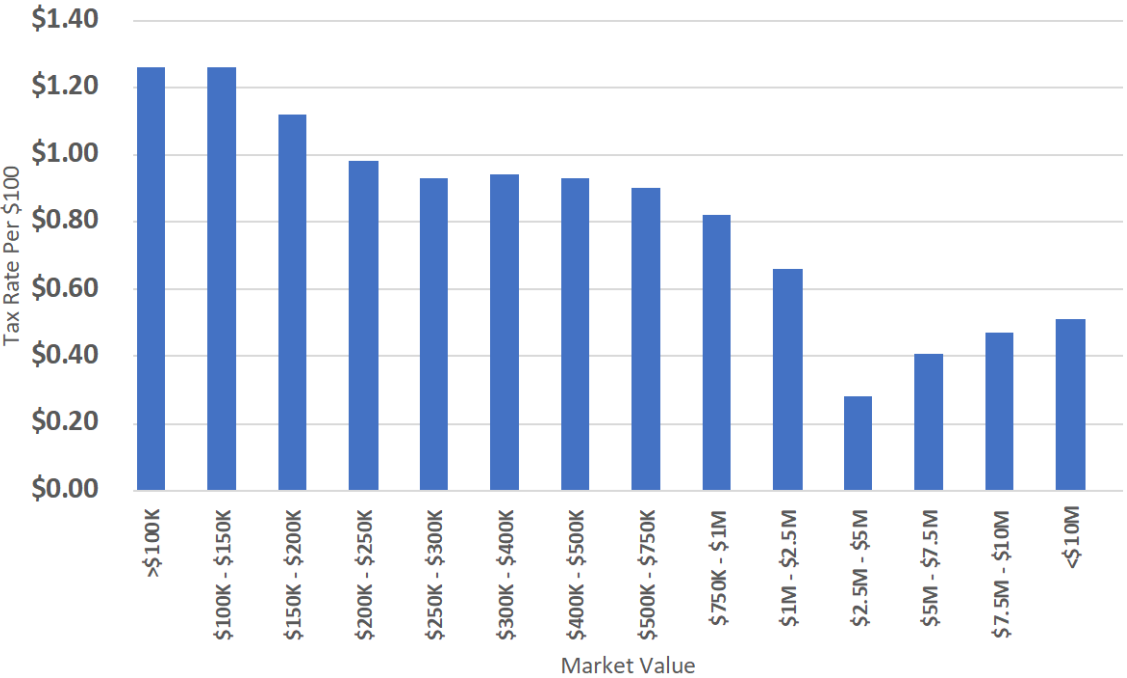
-Spearman's Rank

-Gini Measures

Assessment Policies that Contribute to Regressivity

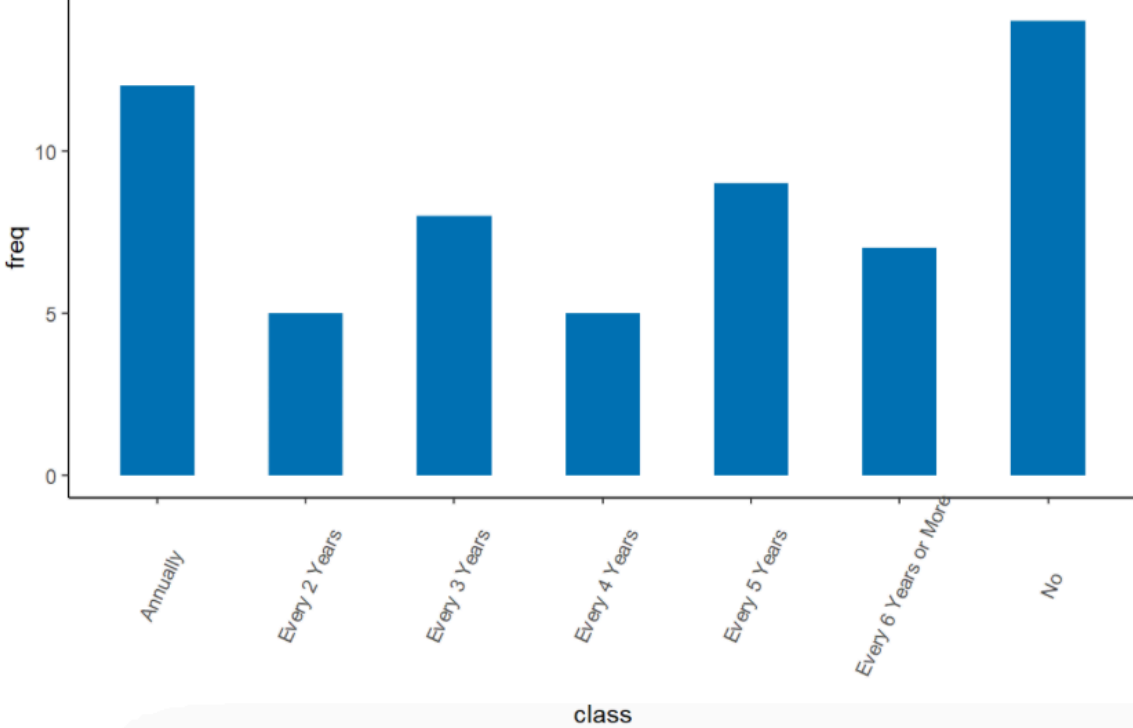
Caps on Assessment Growth

NYC: Effective Tax Rate by Market Value in FY 21
1- to 3-Family Homes



Infrequent Revaluations

Mandated Reassessment Cycle Frequency



PTAPP 2017, Question 39

Assessment Regressivity in a Well-Functioning Assessment Jurisdictions

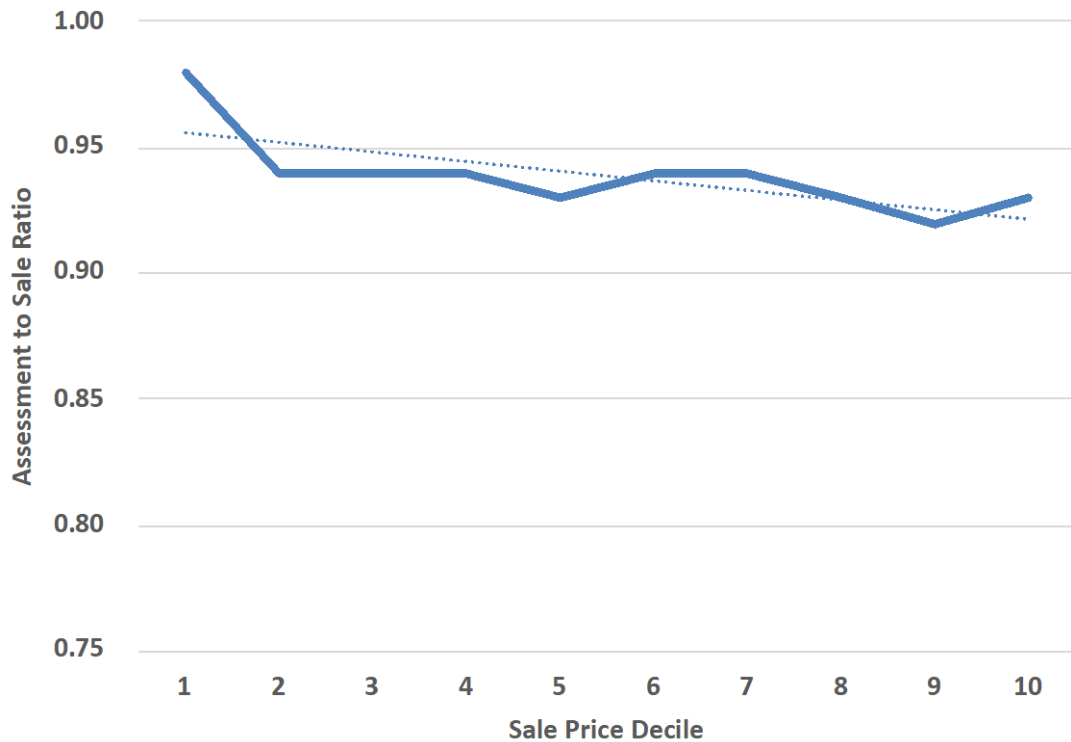
Boston provides an example of an assessment jurisdiction that:

- Has no limits on assessments
- Adjusts assessments annually to reflect changes in the real estate market
- Uses AVMs, GIS and other mass appraisal tools to produce assessments



Boston Vertical Equity Results

Median ASR by Sale Price Decile



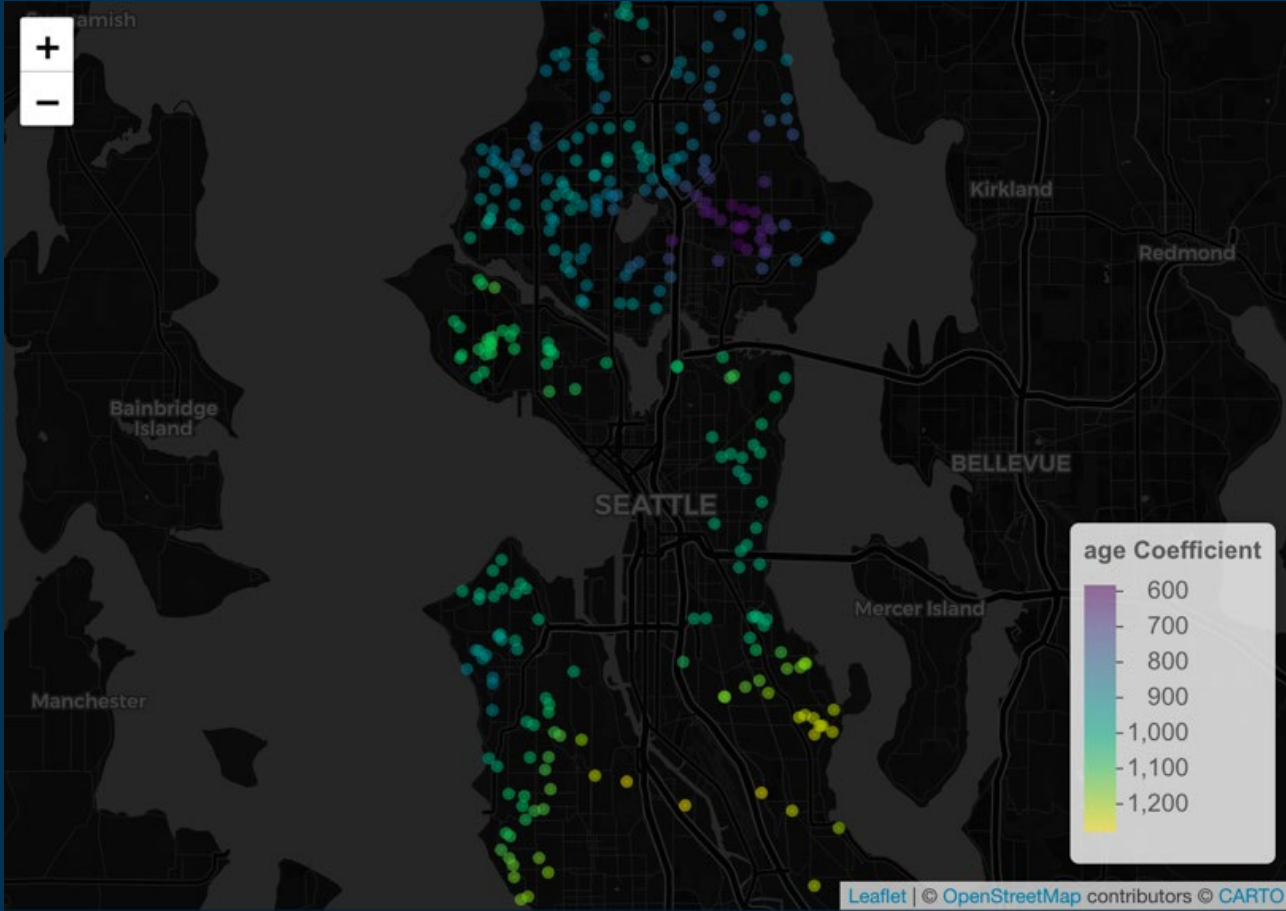
- All statistics are well within the IAAO Standards for Vertical Equity, but....
- Sales ratios by decile, PRD and PRB all indicate slightly regressive assessments.

| Median ASR | PRD | PRB |
|------------|-------|--------|
| 0.938 | 1.011 | -0.011 |

Geographically Weighted Regression

- Spatial machine learning algorithm
- Loop that performs a local regression at each sale (using XY coordinates)
- Nearby observations receive more weight before solving for coefficients
- Coefficients are optimized to minimize residuals (error) for each location
- When used as an AVM, typically achieves better ratio studies than traditional MRA models
- Brunsdon *et al.* 1996

Geographically Weighted Regression











.1



.1



.85



.90



.75



.95



.3



.95



.1



.1

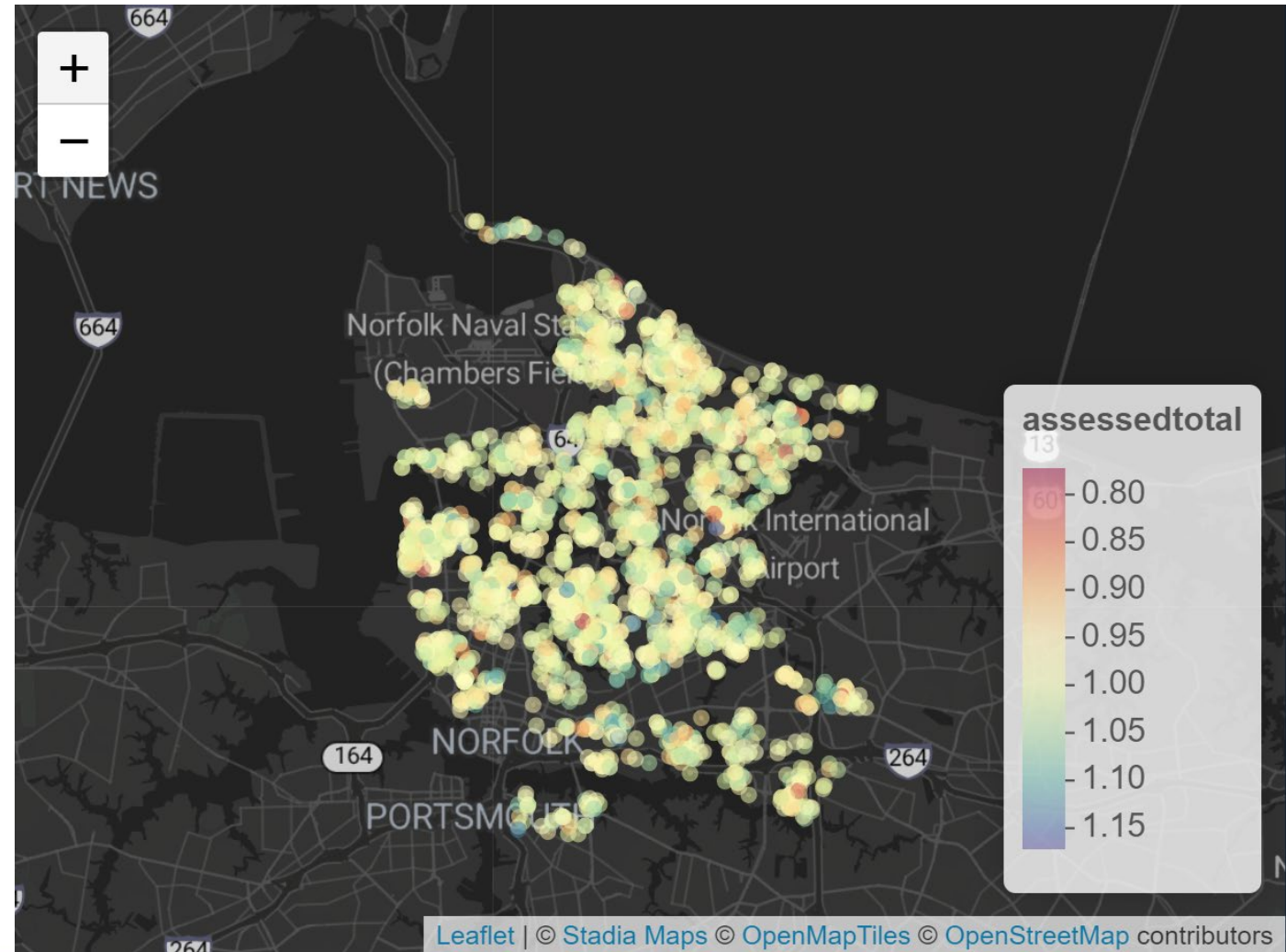
New App In R&D – Geographically Weighted Regression Explorer

Uses geographically weighted regression (GWR) to:

1. Estimate whether assessed values align with market values consistently across locations.
 - Regresses sale price on assessed value (restricted intercept).
 - Ideally, coefficients will be close to 1, indicating a \$1:\$1 average relationship between assessed and market values.
2. Estimate whether sales ratios are consistent across different property value ranges and locations.
 - Regress natural logarithm of sales ratio on natural logarithm of sale price
 - Ideally, coefficients will be close to zero, suggesting that ratios remain stable regardless of the property's value at each location

Lincoln Institute's New App – GWR

- GWR outputs plots statistically significant results on an interactive map
- Essentially localized vertical equity measurements
- Not intended as a “pass/fail” test, merely suggestions for additional analysis



Thank you!



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